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TRANSMITTAL FORM (to be used for all correspondence after initial filing)	Application Number	10/536,571
	Filing Date	November 2, 2005
	First Named Inventor	Taro KISHIBE, et al.
	Art Unit	2811
	Examiner Name	To Be Assigned
	Attorney Docket No.	AOY-3992US
Total Number of Pages in This Submission		16

ENCLOSURES (Check all that apply)		
<input type="checkbox"/> Fee Transmittal Form <input type="checkbox"/> Fee Attached	<input type="checkbox"/> Drawing(s)	<input type="checkbox"/> After Allowance Communication to TC
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Firm Name	RatnerPrestia		
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Printed Name	Lawrence E. Ashery		
Date	March 1, 2006	Reg. No.	34,515

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This collection of information is required by 37 CFR 1.5. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Office, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, ALEXANDRIA, VA 22313-1450.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Taro KISHIBE, et al.

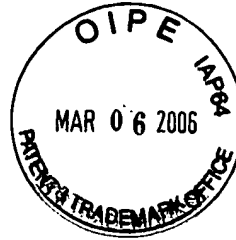
Serial No.: 10/536,571

Group No.: 2811

Filed: November 2, 2005

Examiner: To Be Assigned

For: METHOD AND APPARATUS FOR
ESTIMATING ROTOR POSITION OF
SWITCHED RELUCTANCE MOTOR,
AND METHOD AND APPARATUS FOR
SENSORLESS CONTROL OF
SWITCHED RELUCTANCE MOTOR (AS
AMENDED)



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1. Attached is a copy of the official filing receipt received from the PTO in the above application for which issuance of a corrected filing receipt is respectfully requested.

2. There is an error with respect to the following data:

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Error in

1. ☐ Applicant's name
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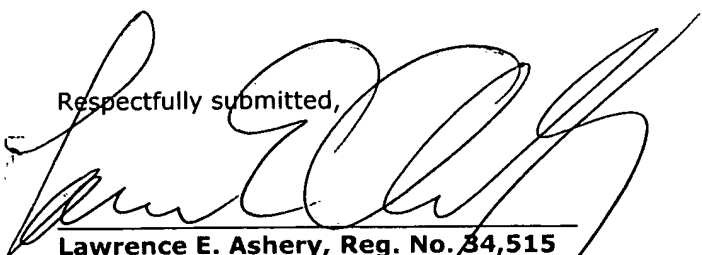
Correct data

- 1.
- 2.
3. **METHOD AND APPARATUS FOR
ESTIMATING ROTOR POSITION OF
SWITCHED RELUCTANCE MOTOR, AND
METHOD AND APPARATUS FOR SENSORLESS
CONTROL OF SWITCHED RELUCTANCE
MOTOR (Preliminary Amendment filed
05/26/05)**
- 4.
- 5.
- 6.
- 7.

3. No fee is due.

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Valley Forge, PA 19482-0980
(610) 407-0700

Respectfully submitted,


Lawrence E. Ashery, Reg. No. 34,515

CERTIFICATE OF MAILING (37 CFR 1.8a)

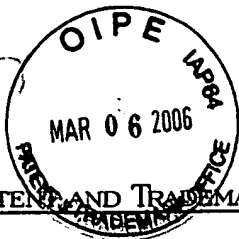
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10/536,571	11/02/2005	2811	3090	AOY-3992US	21	12	11

52473
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Applicant(s)

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Power of Attorney: The patent practitioners associated with Customer Number 52473.

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/JP02/12412 11/28/2002

Foreign Applications

Projected Publication Date: 05/25/2006

Non-Publication Request: No

Early Publication Request: No

Title

Method and apparatus for estimating rotor position and for sensorless control of a switched reluctance motor

*of switched reluctance motor
 and method and apparatus*

COPY



AOY-3992US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appln. No: To Be Assigned
Applicant: T. Kishibe et al.
Filed: Herewith
Title: METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION AND FOR
SENSORLESS CONTROL OF A SWITCHED RELUCTANCE MOTOR
TC/A.U.:
Examiner:
Confirmation No.:
Docket No.: AOY-3992US

PRELIMINARY AMENDMENT

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Sir:

Prior to examination, please amend the above-identified application as follows:

- ☒ **Amendments to the Title** begin on page 2 of this paper.
- ☒ **Amendments to the Specification** begin on page 3 of this paper.
- ☒ **Amendments to the Claims** are reflected in the listing of claims which begins on page 4 of this paper.
- ☐ **Amendments to the Drawings** begin on page _____ of this paper and include an attached replacement sheet(s).
- ☐ **Amendments to the Abstract** are on page _____ of this paper. A clean version of the Abstract is on page _____ of this paper.
- ☐ **Remarks/Arguments** begin on page _____ of this paper.
- ☒ **Please enter the enclosed Article 34 Amendment.** ←

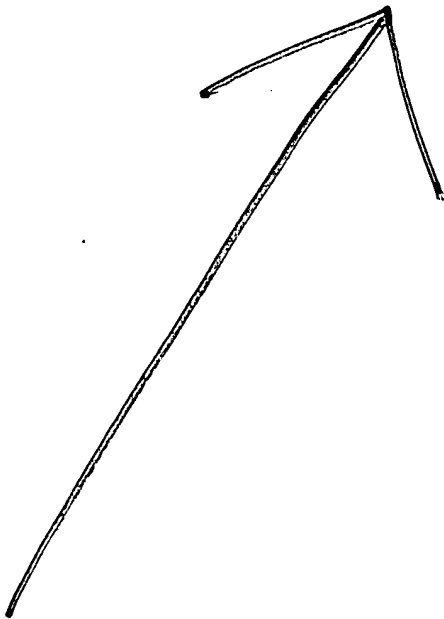
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Amendments to the Title:

Please replace the title with the following:

~~METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION AND FOR SENSORLESS
CONTROL OF A SWITCHED RELUCTANCE MOTOR~~

METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION OF SWITCHED RELUCTANCE
MOTOR, AND METHOD AND APPARATUS FOR SENSORLESS CONTROL OF SWITCHED
RELUCTANCE MOTOR



COPY

Amendments to the Specification:

Please add the following new paragraph after the title and before the paragraph starting on page 1, line 6:

THIS APPLICATION IS A U.S. NATIONAL PHASE APPLICATION OF PCT INTERNATIONAL APPLICATION PCT/JP2002/012412.

COPY

Amendments to the Claims: This listing of claims will replace all prior versions, and listings, of claims in the application

Listing of Claims:

1. (Previously Presented) A control method of a switched reluctance motor comprising:
 - (a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
 - (b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;
 - (c) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r , the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor; and
 - (d) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on a timing at which the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r .

2. (Previously Presented) A control method of a switched reluctance motor comprising:
 - (a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;
 - (b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
 - (c) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;
 - (d) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r , the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;
 - (e) when the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r during the active conduction of a phase, performing once the following procedures including,
 - (a₁) determining estimated rotor position information θ_{cal} which is set at the reference angle θ_r related to the flux-linkage λ_r , or
 - (a₂) determining estimated rotor position information θ_{cal} from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model or inductance model, or

- (a₃) determining estimated rotor position information θ_{cal} by adding a correction angle Φ to the reference angle θ_r related to the flux-linkage λ_r ; and
- (b) calculating an absolute rotor position θ_{abs} by adding the estimated rotor position information θ_{cal} to a stoke angle of the motor, and
- (c) determining and updating the incremental rotor angle $\Delta\theta$ by processing an error between the absolute rotor position θ_{abs} and the estimated rotor position θ_{est} through either one of a proportional-integral control and a proportional control; and

(f) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase based on the estimated rotor position θ_{est} .

3. (Previously Presented) A control method of a switched reluctance motor comprising:

- (a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
- (b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;
- (c) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r , the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;
- (d) when the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{cal} which is set at the reference angle θ_r related to the flux-linkage λ_r ;

(b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the estimated rotor position information θ_{cal} in the previous cycle is determined; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and the turn-off delay and turn-on delay relating to the reference angle θ_r .

4. (Previously Presented) A control method of a switched reluctance motor comprising:

- (a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
- (b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;
- (c) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r , the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;
- (d) when the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r during the active conduction of a phase, performing once the following procedures including,
 - (a₁) determining estimated rotor position information θ_{cal} from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model and inductance model, or
 - (a₂) determining estimated rotor position information θ_{cal} by adding a correction angle Φ to the reference angle θ_r related to the flux-linkage λ_r ; and
 - (b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the estimated rotor position information θ_{cal} in the previous cycle is determined; and
 - (c) correcting a turn-on delay and a turn-off delay which are related to the reference angle θ_r based on the estimated rotor position information θ_{cal} ; and
- (e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and the corrected turn-off and turn-on delays.

5. (Cancelled)

6. (Previously Presented) A control method of a switched reluctance motor comprising:

- (a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;
- (b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
- (c) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;

(d) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_m ($n=1,..,k$), each of the reference flux-linkages λ_m ($n=1,..,k$) related to each of reference angles θ_m ($n=1,..,k$) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(e) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_m during the active conduction of a phase, performing once the following procedures including,

(a₁) determining estimated rotor position information θ_{caln} ($n=1,..,k$) which is set at the reference angle θ_m related to the flux-linkages λ_m , or

(a₂) determining estimated rotor position information θ_{caln} ($n=1,..,k$) from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model or inductance model, or

(a₃) determining estimated rotor position information θ_{caln} ($n=1,..,k$) by adding a correction angle Φ to the reference angle θ_m related to the flux-linkages λ_m ; and

(b) calculating an absolute rotor position θ_{abs} by adding the estimated rotor position information θ_{caln} to a stoke angle of the motor, and

(c) determining and updating the incremental rotor angle $\Delta\theta$ by processing an error between the absolute rotor position θ_{abs} and the estimated rotor position θ_{est} through either one of a proportional-integral control and a proportional control; and

(f) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase based on the estimated rotor position θ_{est} .

7. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;

(c) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_r ($n=1,..,k$), each of the reference flux-linkages λ_r ($n=1,..,k$) related to each of reference angles θ_r ($n=1,..,k$) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(d) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_m during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{caln} ($n=1,\dots,k$) which is set at the reference angle θ_m related to the flux-linkages λ_m ;

(b) calculating and updating an incremental rotor angle $\Delta\theta_n$ ($n=1,\dots,k$) by using an elapsed time from the instant at which the estimated rotor position information θ_{caln} in the previous cycle is determined;

(c) when the calculated flux-linkage λ_{ph} becomes greater than the maximum reference flux-linkage λ_{rk} , averaging the incremental rotor angles $\Delta\theta_n$ ($n=1,\dots,k$) to determine and update an incremental rotor angle $\Delta\theta$; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and turn-off delay and turn-on delay related to the reference angle θ_m ($n=1,\dots,k$).

8. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;

(c) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_m ($n=1,\dots,k$), each of the reference flux-linkages λ_m related to each of reference angles θ_m ($n=1,\dots,k$) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(d) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_m during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{caln} ($n=1,\dots,k$) from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model and inductance model,

(b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the estimated rotor position information θ_{caln} in the previous cycle is determined,

(c) when the calculated flux-linkage λ_{ph} becomes greater than the maximum reference flux-linkage λ_{rk} , averaging the incremental rotor angles $\Delta\theta_n$ ($n=1,\dots,k$) to determine and update an incremental rotor angle $\Delta\theta$, and

(d) correcting a turn-on delay and turn-off delay which are related to the reference flux-linkages λ_{rn} , based on the estimated rotor position information θ_{caln} ; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and the corrected turn-off and turn-on delays.

9. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;

(c) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_{rn} ($n=1,\dots,k$), each of the reference flux-linkage λ_{rn} ($n=1,\dots,k$) related to each of reference angles θ_{rn} ($n=1,\dots,k$) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(d) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_{rn} during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{caln} ($n=1,\dots,k$) by adding a correction angle Φ to the reference angle θ_{rn} related to the reference flux-linkages λ_{rn} ,

(b) calculating an incremental rotor angle $\Delta\theta_n$ ($n=1,\dots,k$) by using an elapsed time from the instant at which the estimated rotor position information θ_{caln} in the previous cycle is determined, and

(c) when the calculated flux-linkage λ_{ph} becomes greater than the maximum reference flux-linkage λ_{rk} , averaging the incremental rotor angles $\Delta\theta_n$ ($n=1,\dots,k$) to determine and update an incremental rotor angle $\Delta\theta$;

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and a turn-off delay and a turn-on delay which are determined according to the reference angle θ_{rn} .

10. (Cancelled)

11. (Cancelled)

12. (Previously Presented) A control method of a switched reluctance motor comprising:

- (a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;
- (b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
- (c) calculating an estimated current I_s from the sensed d.c.-link voltage V_{dc} , the sensed phase current I_{ph} , and a value completely or approximately equal to the minimum value of a motor inductance;
- (d) comparing the sensed phase current I_{ph} with the estimated current I_s ; and
- (e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on a timing when an error between the sensed phase current I_{ph} and the estimated current I_s becomes equal to or less than a predetermined value.

13. (Previously Presented) A control method of a switched reluctance motor comprising:

- (a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;
- (b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
- (c) calculating an estimated current I_s from the sensed d.c.-link voltage V_{dc} , the sensed phase current I_{ph} , and a value completely or approximately equal to the minimum value of a motor inductance;
- (d) comparing the sensed phase current I_{ph} with the estimated current I_s ;
- (e) when an error between the sensed phase current I_{ph} and the estimated current I_s becomes equal to or less than a predetermined value, performing once the following procedures including,
 - (a) determining a rotor position θ_{app} which is related to the estimated current I_s in advance,
 - (b) calculating an absolute rotor position θ_{abs} by adding the rotor position θ_{app} to a stoke angle of the motor, and

(c) determining and updating the incremental rotor angle $\Delta\theta$ by processing an error between the absolute rotor position θ_{abs} and the estimated rotor position θ_{est} through either one of a proportional-integral control and a proportional control; and

(f) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on the estimated rotor position θ_{est} .

14. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;

(b) calculating an estimated current I_s from the sensed d.c.-link voltage V_{dc} , the sensed phase current I_{ph} , and a value completely or approximately equal to the minimum value of the motor inductance;

(c) comparing the sensed phase current I_{ph} with the estimated current I_s ;

(d) when an error between the sensed phase current I_{ph} and the estimated current I_s becomes equal to or less than a predetermined value, performing once the following procedures including,

(a) determining a rotor position θ_{app} which is related to the estimated current I_s in advance;

(b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the rotor position θ_{app} in the previous cycle is determined; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on the incremental rotor angle $\Delta\theta$, and a turn-off delay and a turn-on delay which are related to the rotor position θ_{app} .

15. (Cancelled)

16. (Cancelled)

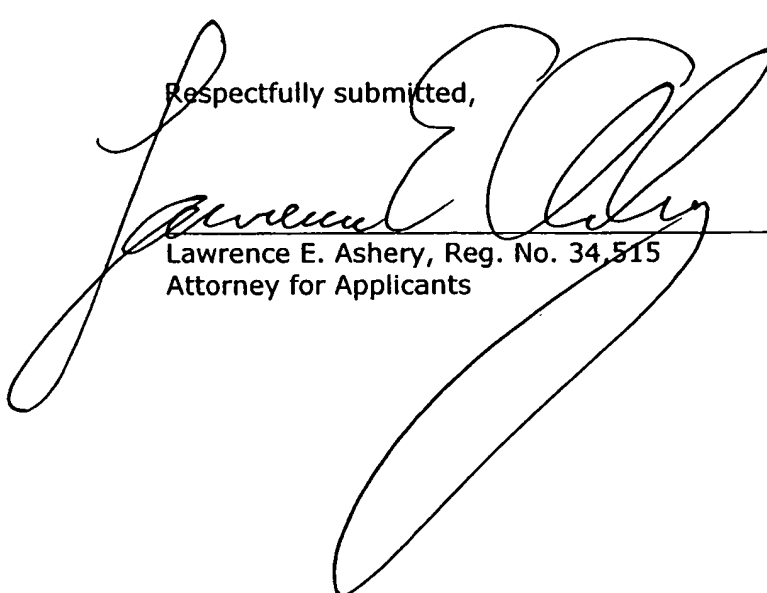
17. (Cancelled)

18. (Previously Presented) An apparatus which is controlled in the method according to any one of claims 1 to 4, 6 to 9, 12 to 14.

19. (Cancelled)

20. (Cancelled)

Respectfully submitted,


Lawrence E. Ashery, Reg. No. 34,515
Attorney for Applicants

LEA/dlm

Dated: May 26, 2005

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